DETERMINATION OF LUNAR MOTIONS ESSENTIAL TO NAVIGATION

A method is presented for obtaining time-dependent values of the inclination and longitude of the ascending node of the moon's true equator with respect to the ecliptic, and the variation in the moon's rotational rate. The method is based on a systematic program of photography which relates the moon to a star background. A common data reduction procedure is applied to three separate observing modes--an earth-based system which employs a specially designed moon camera in conjunction with a separate star camera; a star camera and moon camera placed in a satellite orbiting the moon; and a moon-based system utilizing only a star camera.

The method does not depend on measurements on the lunar limb and the determination of the coordinates of the apparent center of the disk. A photogrammetric procedure is developed, whereby the only requirement on the selection of lunar feature images to be measured is that conjugacy among different photographs can be established. This eliminates a systematic source of error which has existed in classical procedures. The expected accuracies for the determination of the physical librations are:

Earth-based system	± 20"
Lunar-satellite system	± 1"
Moon-based system	±0.1"

GEOCENTRIC POSITION SYSTEM WITH STAR-MOON PHOTOGRAPHS

A position based on moon measures made in a certain way is free from deflection of the vertical and therefore is useful in establishing absolute position.

The occultation program generated by Dr. O'Keefe requires simultaneous observation of the star transit of the moon's limb at two widely separated places. The difficulty of obtaining cloud-free skies at two widely separated places at specific times results in one observation in eight being successful.

An alternate method developed by Dr. Markowitz employs a 13 foot telescope with moon and star IMC. The data reduction equations require star directions, the moon direction and the moon distance.

The new method proposed employs a tangential solution which is independent of the focal length and requires only dimensionless data from the moon. The first property permits a camera to be employed with a one foot focal length. The second property should lead to greater accuracy since the direction of the moon is an order more accurate than the distance.

The method proposed therefore has the operational advantage of the Markowitz technique with greater portability and possibly greater accuracy. The latter remains to be established.

NEW FIRST ORDER ZENITH CAMERA

POSITIONING SYSTEM

A first order zenith camera positioning system has been developed with which the direction of gravity at a camera station may be determined to ±0.''1 providing the imaged star places have the corresponding accuracy.

The new level of accuracy achievable with the first order zenith camera system arises from:

(1) greater rigidity in the camera construction,
(2) greater accuracy in the vertical orientation,
(3) larger lens diameter leading to a larger number of useable stars per plate,
(4) more accurate timing of the shutter opening and closing,
(5) method of leveling randomizes the vertical orientation,
(6) method of leveling is independent of the errors of the vertical spindle, and
(7) provides a greater redundancy on each plate.
(8) The data reduction equations are independent of systematic zonal errors, plate inclination and are adapted to single star rejection.

A zenith camera position plate may be obtained any time a 16° region of the zenith is cloud-free for five or more minutes.

Experience demonstrates that in remote areas of unfavorable weather 10 or more zenith camera positions can be obtained for every position obtained with a first order theodolite or astrolabe. Not only do the latter instruments require a larger area of the sky for a larger period of time but at specific times since these instruments observed preselected meridian transit or almucantor transit stars.

The zenith camera system having operational advantages is clearly competitive with the capacity for comparable accuracy.

STAT

28 May 1963

Mr. John C. Whitaker
Aero Service Corporation
210 East Courtland St.
Philadelphia 20, Penn.

Dear John:

Thank you very much for sending me a copy of Search, new publication of Aero Service's Exploration Division.

Congratulations on the quality of your first issue of Search. Because of the unique factors and unusual circumstances involved in its several articles, the magazine made fascinating reading.

Please place me on your distribution list to receive future copies.

Sincerely,

Arthur C. Lundahl

Orig - Mr. Whitaker
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